

## Evaluation of Health Indicators and the Quality of Used Frying Oils in Fast Food Restaurants of Mashhad in 2018

Zohreh Rahnema Bargard<sup>1,2</sup>, Hossien Alidadi<sup>2</sup>, Monavvar Afzal Aghaee<sup>3</sup>,  
Mahnaz Kharghani<sup>4</sup>, Mahsa Mahjoubzadeh<sup>5</sup>, Fatemeh Kariminejad<sup>2\*</sup>

<sup>1</sup> Student Research Committee, Mashhad University of Medical Sciences, Mashhad, Iran.

<sup>2</sup> Department of Environmental Health Engineering, School of Health, Mashhad University of Medical Sciences, Mashhad, Iran.

<sup>3</sup> Department of Statistics and Epidemiology, School of Health, Mashhad University of Medical Sciences, Mashhad, Iran.

<sup>4</sup> Department of Environmental Health Engineering, No.3 Health Center, School of Health, Mashhad University of Medical Sciences, Mashhad, Iran.

<sup>5</sup> Department of Environmental Health Engineering, Samen Health Center, School of Health, Mashhad University of Medical Sciences, Mashhad, Iran.

### ARTICLE INFO

#### ORIGINAL ARTICLE

#### Article History:

Received: 23 November 2019

Accepted: 20 January 2020

#### \*Corresponding Author:

Fatemeh Kariminejad

Email:

Kariminezhad136618@gmail.com

Tel:

+985131892002

#### Keywords:

Fast Foods,

Polar Materials,

Fatty Acids,

Nonesterified,

Health Status Indicators.

### ABSTRACT

**Introduction:** Recently, changes in people's lifestyles and new eating habits have diminished the importance of main dishes and have led to increasing the consumption of fast foods. Therefore, paying close attention to the health conditions and safety of the food provided in these centers can dramatically reduce the incidence of various diseases. The present study examines the environmental health status and the quality of used frying oils (the most important health assessment indicators of fast food restaurants) in the fast food shops and restaurants of the metropolis of Mashhad in the areas adjacent to the holy shrine which has the highest number of pilgrims and tourists.

**Materials and Methods:** A total number of 120 of fast food shops were selected by quota sampling method and were sampled during peak working times. The environmental health status of these centers was evaluated based on food, drink, cosmetics, and health material regulation. Demographic data of personnel, area and antiquity, type, duration and frequency of using oil, the temperature, TPM, and FFA were also measured.

**Results:** According to the results; 32.5% of the subjects were in hygienic status, and 67.5% of the subjects were in sanitary status. Palm oil was the most widely used oil type. TPM and FFA indices were in the unfavorable condition in 49 samples (40.8%) and 75 samples (62.5%), respectively. There was a significant relationship between temperature, the period of using oil and TPM, and FFA indices.

**Conclusion:** According to the high volume of customers, quality and health assurance of food is of utmost importance. Therefore, the importance of renovating the buildings, training the operators and staff, continuous monitoring, and applying severe legal measures can be the most important corrective actions.

**Citation:** Rahnema Bargard Z, Alidadi H, Afzal Aghaee M, et al. *Evaluation of Health Indicators and the Quality of Used Frying Oils in Fast Food Restaurants of Mashhad in 2018*. J Environ Health Sustain Dev. 2020; 5(1): 935-47.

### Introduction

Recently, changes in people's lifestyles and new eating habits have diminished the importance of main dishes and have led to increasing the

consumption of fast foods<sup>1</sup>. Fast foods include all types of sandwiches, hamburgers, cheeseburgers, fried chicken, fish and shrimp, hot dogs, fried potatoes, chicken nuggets, pizzas, and sausages<sup>2</sup>.

The consumption of these foods due to their good taste, high energy, fast preparation, and low prices has dramatically increased in all countries and especially among youth and teenagers<sup>3-5</sup>. According to the latest surveys done by the central bank of the Islamic Republic of Iran, by the end of 2015, each Iranian household spent 711,000 Tomans (equal to 2% of total household expenditure) to buy fast food, annually. However, only less than 5% of fast food restaurants surveyed in Iran have the necessary hygiene quality in different areas namely personal, food, tool and equipment, and building hygiene<sup>6, 7</sup>. Failure to comply with these health tips can lead to various diseases among consumers<sup>8</sup>. These diseases, which occur through eating unhealthy foods, are caused by a variety of viruses, bacteria, parasites, chemicals, and allergens that impose a serious threat to the public health and impose high health care costs on consumers<sup>9</sup>. Accordingly, greater supervision and control over the implementation of health regulations have been recently introduced by environmental health experts and other medical groups as the main programs of the Ministry of Health and Medical Education so that strong laws and regulations can reduce the harmful effects of environmental pollution to the lowest possible level<sup>10, 11</sup>. One of the most important measures for this purpose is food, drink, cosmetics and health materials regulation which is used to determine the methods for controlling of and dealing with the offenders in the so-called centers for the preparation, distribution, maintenance, sale, and transportation of food, beverages, and cosmetics, and in the public places which are currently running in the country<sup>10</sup>.

Another factor that strongly influences the quality of food prepared in fast food centers is the quality of frying oil used. Deep frying is one of the most common food preparation methods especially in fast foods which creates a pleasant taste, texture, and good appearance for the food<sup>12, 13</sup>. Improving the sensory quality of food caused by the formation of aromatic compounds, attractive color, shell, and texture have also caused a large number of harmful reactions<sup>14, 15</sup>. At the frying temperature (which sometimes reaches up to 200°C); the oxidized fats,

trans-fatty acids, hydrolyzed fats, sterol derivatives, polymers, polar compounds, acrylamide, and heterocyclic compounds are formed<sup>16</sup>. The non-volatile insoluble material produced also increases the viscosity of the oil and darkens its color and reduces the smoke point<sup>15</sup>. There is no specific criterion for determining the useful life of oils<sup>17</sup>; therefore, continuous monitoring of the quality of fat and oil during food preparation and processing is very necessary and important<sup>12</sup>. According to the National Iranian Standards Organization Standard No. 4152, measurement of Total Polar Materials (TPM) and Free Fatty Acids (FFA) are the most important indicators to evaluate the usability or non-usability of frying oil<sup>18</sup>. Most of the non-volatile by-products are known as TPMs<sup>19</sup>. TPMs are the best indicators for checking the quality and evaluation of frying oils<sup>20</sup>. They consist of dimeric fatty acids, polymerized triglycerides (PTG), aldehydic triglycerides, triglyceride mono hydroperoxides, and cyclic fatty acid monomers<sup>21</sup>. The percentage of TPM in cooking oils is approximately equal to that in food-absorbing oils<sup>22</sup>. FFA is also an indicator of the acidity and hydrolysis of oil. In other words, the formation of FFA and glycerol residues is the result of the oil hydrolysis reaction<sup>23</sup>. FFA is one of the major causes of flavor deterioration and shelf life decrease of oil and is used as an indicator for monitoring the efficiency of oil deodorizers which has a critical role in edible oil and quality control analyses<sup>24, 25</sup>.

Regarding the environmental health status of food centers, only four internal studies (3 in restaurants and only 1 in a fast food restaurant) have been done. The study was conducted in 24 restaurants of Zahedan which showed that all of the workers of restaurants and dining halls had the personal health card, and they have passed public health courses. 80 percent of the restaurants were in poor condition. There was no problem in the kitchen and restaurant appearance in terms of hygiene, and most of the health parameters have been taken into consideration<sup>26</sup>. The results for a similar study in Qaemshahr restaurants revealed that only 50 percent of restaurant staff had a health certificate and a medical examination card<sup>27</sup>. Only 1 study has been

conducted regarding the environmental health status of fast food distribution centers in Yasuj; in this study conducted on 20 fast food distribution centers, more than 50% of staff did not wear hygiene uniform; 31.6% had no health cards, and 84.2% of them received money from customers directly. None of the workers used gloves, only 1 of them used the chef hat and 31.6% of personnel did not know how to wash the vegetables<sup>28</sup>.

In evaluating the quality of the oil used, the most attention was paid to measuring the peroxide value. In the study conducted in Ilam; the peroxide value of 195 sandwich and Falafel samples was measured and the peroxide value of the used oils was seen to be higher than the standard level. This value was also higher than the acceptable limit for 58 fried food samples in Lahijan sandwich stores and restaurants, and 80% of the samples had peroxide values above 8<sup>29</sup>.

Investigation of previous studies has shown that there is a lack of study in the context of evaluating the health indices and quality of used oils (TPM and FFA indices) which can be very important and necessary considering the popularity of these foods especially among adolescents. In addition, investigating the relationship between environmental health status and these indicators can also help in the proper planning for future control and more educational methods.

The present study was conducted to evaluate the health indicators namely TPM and FFA in the fast

food shops and restaurants of Mashhad in the areas adjacent to the holy shrine which has the highest visit of pilgrims and tourists.

### Materials and Methods

An analytical study was conducted to evaluate the environmental health status and the quality of used oils (TPM and FFA) in Mashhad fast food shops and restaurants.

#### Study area

The present study was conducted in Mashhad which is known as the second largest religious metropolis in the world and the second largest metropolis of Iran. The best attraction of Mashhad is the shrine of Imam Reza which is the main reason for travelling of millions of pilgrims and travelers from different cities of Iran and from other countries around the world. The holy shrine is located in the central part of the Mashhad, so this has led to introducing this area as one of the main and one of the most important parts of the city<sup>30-32</sup>. This has led to a high concentration of resorts, hotels, motels and a high density of restaurants and fast food shops in the area. Accordingly, the present study was carried out in the fast food shops and restaurants covered by Mashhad Health Centers No. 5 and Samen which are located around the holy shrine. The geographical location of Mashhad and the under study area are shown in Figure 1.



**Figure 1:** The location of Mashhad and the under study area

### Identifying fast food shops and restaurants

To investigate fast food shops and restaurants, the list of fast food shops was provided from the health centers of the mentioned area and a total of 120 fast food preparation and distribution centers were selected by the quota sampling method. This method provided non-probability samples that are controlled to be distributed like a random sample from a population<sup>33</sup>. It is known as a useful method when probability sampling techniques are

not possible when they are cost-effective, and easy by quick usability<sup>34</sup>. The sample size was calculated according to Sajjadi et al. study<sup>35</sup>. Visits and sampling were conducted during the winter season from Wednesday to Friday at the peak of working times of the shops (18-23). General information about the fast food shops and restaurants was selected and the type of fast food restaurant was offered by these shops are shown in Table 1.

**Table 1:** The type of fast food provided by the fast food shops and restaurants in the study area

Type of fast food provided	Frequency, No. (%)
Hot dog	32(26.7)
Fried potatoes	26(21.7)
Falafel	21(17.5)
Cocktail	21(17.5)
Hamburgers	8(6.7)
Others	12(9.9)
Total	120(100)

### Evaluation of environmental health indicators of fast food shops and restaurants

In order to evaluate the environmental health status of these centers; the checklist of food, drink, cosmetics and health materials regulation was used and the health status of the studied shops was evaluated in terms of four aspects including individual health, food, tools and equipment, and buildings. The number of 100 was considered as the total score for each index, and the health status was divided as follows: undesirable level (score  $\leq 50$ ), average level (51-70), and desirable level ( $> 70$ ). Demographic information including age, sex, education, work experience and environmental factors of the shops including year of establishment, health and sanitation status, and area were collected using checklists.

### TPM and FFA measurement

Oil sampling was performed according to the national standard of 493 which is approved by the National Institute of Standards and Industrial Research<sup>36</sup>. For measuring the temperature, polarity and free fatty acid content of the oil samples, a portable cooking oil tester (DOM-24

model manufactured by ATAGO, Japan) was used. According to the guidelines of the Iranian National Standards Organization, the maximum permissible limit for the TPM index is 25, whereas the maximum permissible limit for FFA is 1<sup>37, 38</sup>. Measurements were performed 3 times and the results were reported as the mean score.

### Statistical analysis

SPSS and Excel software were used for data analysis and presentation. The significance level was set at 0.05. Accordingly, the Kolmogorov-Smirnov test was used to check the normality of the data, and the Mann-Whitney test and Kruskal-Wallis test were applied to compare the quantitative variable with abnormal distribution in two groups and more than two groups, respectively. Edraw Max software was also used for drawing the various diagrams.

### Ethical issues

This study was approved by the Medical Ethics Committee of Mashhad University of Medical Sciences No: IR.MUMS.REC. 1397.214

### Results

#### Demographic characteristics of personnel

As mentioned above, the demographic characteristics of the personnel were checked using a checklist, and the results were shown in Table 2. All of the staff working in these shops was male, and 80% of the study population had a diploma

degree or lower. 56.7% of the personnel had the work experience of fewer than 5 years. Furthermore, 74.2% of the personnel had a health card, and 48.3% had a health certificate.

**Table 2:** Describing the demographic characteristics of the personnel in fast food centers

Variable, Type	Frequency, No. (%)
Gender	
Male	120(100)
Female	0(0)
Age(year)	
< 25	4(3.3)
26- 45	92(76.7)
> 45	24(20)
Level of education	
Under diploma	38(31.7)
Diploma	58(48.3)
Associate	12(10)
Bachelor	12(10)
Work experience(year)	
< 2	39(32.5)
2- 5	29(24.2)
6- 10	23(19.2)
11- 15	9(7.5)
> 15	20(16.7)
Having health certificate	
Yes	58(48.3)
No	62(51.7)
Health card	
Yes	89(74.2)
No	31(25.8)

### ***The Area and age of fast food shops***

As mentioned above, the designed checklist was used to check the area and the age of the fast food shops. The results were reported in Table 3. Based on this experiment, 51.7% of the examined shops had the age of less than or equal to 5 years. In

addition, the area of food preparation in these shops was observed and is as follows: less than 25 m<sup>2</sup> (51.7% of the studied shops), between 25 and 50 m<sup>2</sup> (41.7% of studied shops) and more than 50 m<sup>2</sup> (6.6% of studied shops).

**Table 3:** Age and area of the fast food shops and restaurants in the under study area

Variable, Type	Frequency, No. (%)
Age (year)	
≤ 5	62(51.7)
6- 10	27(22.5)
> 10	31(25.8)
Area(m <sup>2</sup> )	
< 25	62(51.7)
25- 50	50(41.7)
> 50	8(6.6)



### Environmental health status of fast food shops and restaurants

Environmental health status of fast food shops was evaluated based on the food, drink, cosmetics and health materials regulations considering four personal, food, tools and equipment and building factors; the score  $\leq 50$ , the score between 51-70, and the score  $> 70$  were considered as unfavorable level, average level, and desirable level,

respectively. The results demonstrated that out of 120 centers, 12.5%, 5%, 11.7% and 5% of the shops had poor condition in different sections of personal, food, tools and equipment, and building hygiene, respectively (Figure 2). As well, 32.5% of the shops had a healthy condition and 67.5% were in the improving phase and on average, they gained the highest score from the building health index.

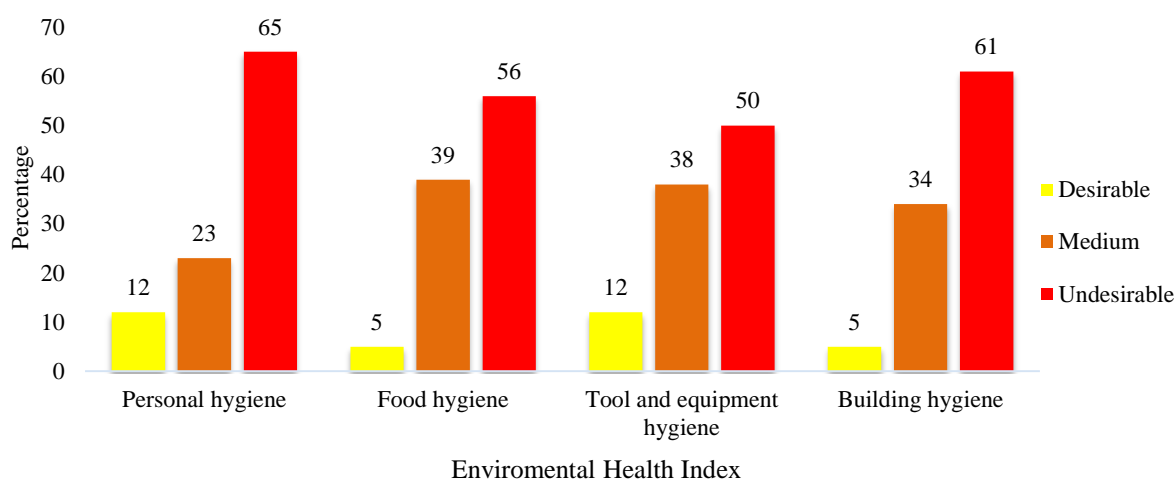


Figure 2: Environmental health status of fast food shops and restaurants

### Quality of oil used for cooking in fast food shops and restaurants

#### Type and the composition of used oil

As it can be seen in Figure 3 and 4, 98% of shops used frying oils, and 46% of the main ingredient composition of used oils was palm. Examination of the type of oil consumed on the

basis of the fast food provided also showed that most types of oils consumed in the fast food for preparation of hot dog, Falafel and hamburger is palm oil; soybean oil is also used for frying the potatoes, and there is a consistent distribution of used oils in centers of cocktail baking.

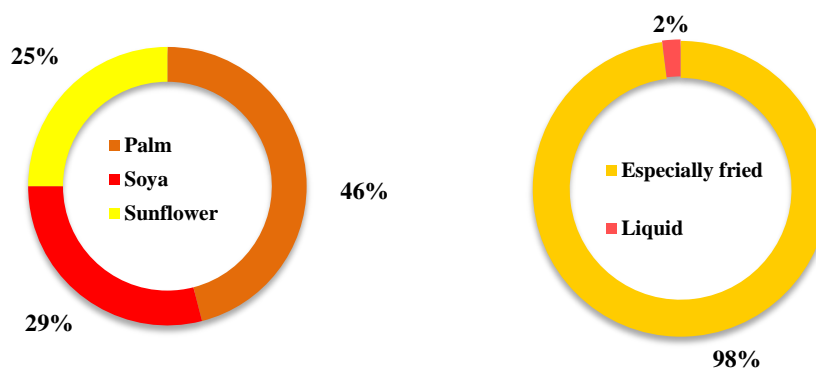


Figure 3: Type and composition of used oils in fast food shops and restaurants

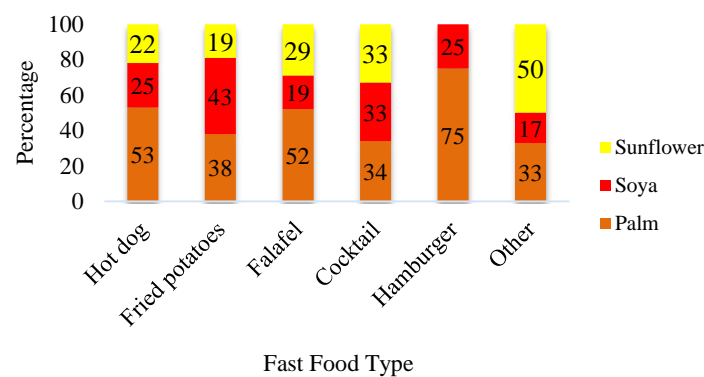


Figure 4: The type of used oil in fast food shops and restaurants according to the type of fast food offered

Time and frequency of using oil

Table 4 demonstrates the duration and frequency of the used oil in the fast food shops and restaurants. Accordingly, the duration of using oil

in more than 90% of cases was less than 5 days, but in more than 40% of shops; changing the oil was occurred after being used for more than 20 clients.

Table 4: Duration and frequency of the used oil in the fast food shops and restaurants

Variable, Type	Frequency, No. (%)
Duration of use (day)	
< 1	54(45)
1- 5	56(46.7)
6- 10	9(7.5)
11- 15	1(0.8)
Frequency of using oil per customer	
≥ 20	69(57.5)
21- 60	38(31.7)
61- 100	8(6.7)
101- 140	5(4.2)

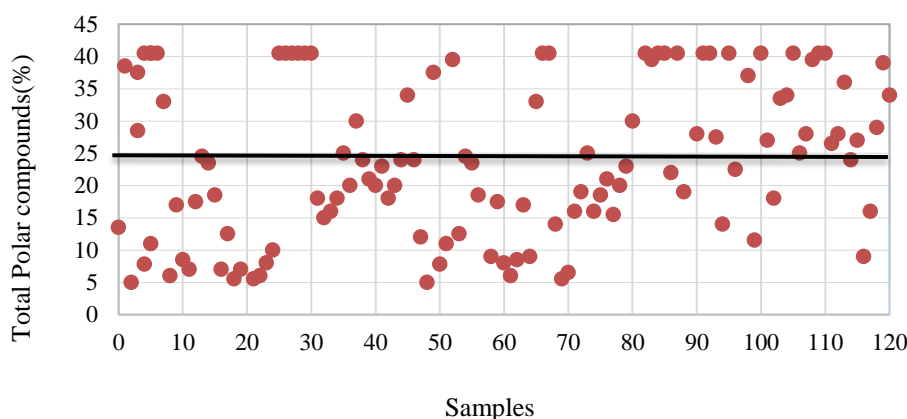
Temperature measurement in used oils

Temperature is one of the important parameters in the quality of oil used in food processing<sup>39</sup>. Temperature measurement in oils used revealed that the temperature of the oils used was in the range of 40- 190°C; so that, in 117 shops (97.5%), the temperature of used oil was in the range of 40-160°C; in 2 cases, it was in range of 160-180°C; and in one shop, it was higher than 180°C.

Measurement of oil TMP

TMP of oil was measured to check the quality of oil used (Figure 5). Results demonstrated that, in terms of TMP, 71 samples (59.2%) were at a desirable level, and 49 samples (40.8%) were at an undesirable level and in discard point states.

Statistical analysis showed a significant relationship between temperature, oil use duration, and TPM ( $P = 0.025$ ). In addition, the shops which had better health status were at a desirable level in terms of oil quality and TPM value ( $P = 0.048$ ). However, there was no relationship between TPM index and the type of oil used (palm, soybean, sunflower), health and sanitation status and demographic data. A significant relationship was observed between the TPM index and geographical location of the oils ( $P = 0.00$ ), and district 7 of the municipality of Mashhad with the average TPM of  $34.03 \pm 7.98$  had the highest amount of TPM in used oils.

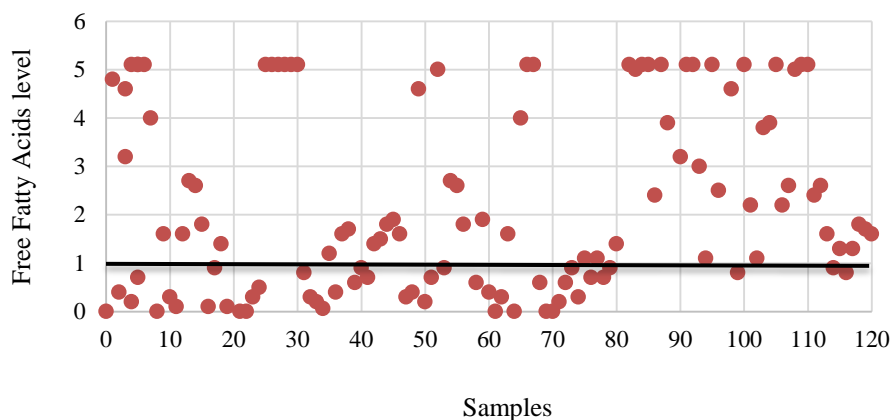


**Figure 5:** TPM values of used oil in fast food preparation and distribution centers

### Measurement of FFA

Another indicator that indicates the oil quality is FFA. As it can be seen in figure 6; the FFA in the samples was in the range of 0–5. FFA index for 45 samples (37.5%) was in a desirable condition, it was in an undesirable condition for 51 samples (42.5%), and it was higher than 5 for 24 samples (20%). Statistical analysis showed a significant relationship between oil use duration and FFA ( $P =$

0.014), but this relationship was not significant between temperature, type of oil used (palm, soybean, sunflower), frequency of oil use, sanitation status and demographic information. Statistical analysis of the geographical location of the shops and FFA index showed that, those shops located in the district 5 of the municipality of Mahshad had the highest values in terms of FFA (mean FFA of  $4.23 \pm 0.99$ ) ( $P = 0.00$ ).



**Figure 6:** FFA values of used oil in fast food preparation and distribution centers

### Discussion

In the present study, the environmental health status of fast food shops and restaurants was evaluated on the basis of four factors, i.e.; personal health, food, tools and equipment, and buildings. The results showed that 12.5%, 5%, 11.7% and 5% of the shops have an undesirable condition, respectively. On average, the highest possible score of the shops was related to the building health index. Although these values

seem to be insignificant; employing more specialized staff is needed for more coherent control and oversight due to the annual increase in the number of tourists and pilgrims in the region, the increasing demand, and the importance of providing appropriate services. Increasing the number and reducing the interval between visits and further monitoring can be among effective parameters in improving current conditions.



Another important consideration is the features and age of the restaurants and shops in the study area and the age of the shops. Restaurants that are fewer than 5 years old and are newly established were in the desirable condition in terms of health status due to upgrading and improving the level of health services offered to attract customers. This clearly demonstrates the importance of renovating and updating the building restaurants and shops. These results are also confirmed by the study conducted by Zangi Abadi et al. on the environmental health assessment of restaurants and hotels in Isfahan<sup>40</sup>. In addition, only 32.5% of the shops were in a good health condition, and 67.5% were only in a sanitation condition. It should be noted that, over time and by increasing the implementing and maintaining costs, more shops will be involved in the problems, and these problems will become more serious and endanger the health of staff and consumers due to the lack of economic justification for managers and owners of the shops<sup>41</sup>.

In the studies conducted to survey the demographic information and the quality of used oils, statistical analysis showed that there is no significant relationship between oil quality and the educational level, work experience and obtaining health licenses. However, factors earning the lowest score in the field of personal and equipment hygiene (the most important in providing healthy food), low education (diploma degree and lower) of 80% of employees, and participation of less than 50% of the shops in obtaining a health certificate indicate the need for paying more attention to education<sup>26, 27</sup>. Vahidi et al. showed that holding monthly training courses for operators could change their attitudes, increase the level of hygiene, and ultimately maintain consumers' health<sup>42</sup>.

Studying the quality of oil used for cooking in fast food shops showed that 45.8% of the oil constituents were belonged to palm, 29.2% to soybean and 25% to sunflower oil. In a study done by Chen et al., it was found that the average amount of fatty acid in the liquid component of palm oil was 0.071 mg KOH/g which was higher

than its component in soybean oil (0.03 mg KOH/g). Normally, the amount of diglyceride in palm oil and soybean oil is 6–8% and 2–3%, respectively<sup>43</sup>. Studies have shown that among the vegetable oils used in deep frying of potato, palm oil increases polar compounds slightly less than sunflower oil<sup>44</sup>. In fact, the peroxide value in palm oils is increased at a slower rate. The presence of palm oil with a relative increase in the amount of saturated fatty acids can improve the desired physical properties of the oil (such as smoke point, low foaming, and viscosity). Considering the low content of fatty acids in palm oils, it has higher resistance compared to other oils<sup>45</sup>.

In the present study, the temperature of the oils used in 117 shops (97.5%) was in the temperature range of 40- 160°C; it was in a range from 180 to 160°C in two cases, and it was above 180°C in only one case. The best temperature range for frying the food is 160-180°C because the quality of oil and fat is deteriorated faster at higher temperatures and, the more oil and fat are absorbed by the foods at a lower temperature. Furthermore, increasing the frying temperature from 180 to 215°C significantly increases the rate of thermal degradation and oxidation<sup>46</sup>. During the frying process, the oil is hydrolyzed in the form of free fatty acid and mono and diglycerides. An increase in these volatile compounds can be attributed to an increase in the content of free fatty acid and polar compounds in the oil<sup>47</sup>. A study conducted on frying oil used in the preparation of fast food in an American restaurant showed that fatty acid contents of oil samples increase by increasing the time and temperature which is consistent with the findings of the present study ( $P = 0.025$ ). Moreover, frying at high temperature leads to increasing the production of carcinogenic and teratogenic compounds and to create some problems in fat and glucose metabolism and liver function<sup>48-50</sup> which not only can threaten consumers of fried foods, but also it can affect employees' health through absorbing vapors and volatile compounds<sup>51</sup>.

In terms of the frequency of the oil use, the results showed that, in 43% of cases, the oil

change was performed for every 20 customers which are not good given the high number of clients. A study conducted in Kuala Lumpur, Malaysia, on cooking oils showed that 67% of operators did not agree to reuse the oil, and 69% believed that reuse of oils is detrimental to health. However, 63% of operators admitted that they have been using used oil frequently<sup>52</sup>. Certainly, the frequency of use in this study was not quantified. Although the relationship between the oil quality indices and the frequency of the oil use was not significant in the present study; the consumption of foods fried by the oils that have been repeatedly consumed is undesirable from the health point of view and may increase cardiovascular diseases<sup>12</sup>.

As mentioned before, in terms of the TPM index, 71 samples (59.2%) were desirable, and 49 samples (40.8%) were undesirable and in a poor condition. Moreover, in terms of FFA, 45 samples (37.5%) had a favorable condition, and 75 samples (62.5%) had an unfavorable condition. Given the meaningful relationship between the oil usage duration and the measured indices; these adverse values may indicate the lack of regular changing of the oil and overuse of the oil which is consistent with findings of the study carried out by Totani et al.<sup>53</sup>. Other factors that contribute to the creation and acceleration of *spicy tastes* of the oil can be heat, degree of unsaturation, light, contamination of oil with spicy fatty substances, and contamination with metal and air<sup>54</sup>. Accordingly, the creation of vacuum frying, regular oil changing and the use of natural antioxidants (vitamin E is most important of them) can be considered as beneficial measures in maintaining the quality of the edible oil<sup>43</sup>. Surely, Ramadan et al. have addressed another aspect and argued that increasing the amount of free fatty acid is not an ideal reliable parameter for the assumption of decomposing the frying oil because it is difficult to distinguish between fatty acid generated by oxidation and fatty acid generated by hydrolysis<sup>55</sup>. In addition, the low molecular weight of free fatty acid may be lost by volatilization during the frying process<sup>17</sup>.

## Conclusion

The results of this study showed that about half of the frying oils used in the preparation of fast foods were undesirable. In addition, considering that the oil quality is affected by factors such as temperature, usage time of the oil and its relationship with different areas of environmental health according to food, drink, cosmetics and health materials low; paying attention to the importance of renovation of buildings, training the employers and staff, continuous provision, monitoring and implementing strict legal measures to deal with offenders can be considered as the most important corrective measures. Besides, lack of awareness among staff and managers of the restaurants and fast food centers about the deleterious effects of frying oil and lack of timely detection of the oil changing time are of the main causes of corruption and lower quality of edible oils which ultimately can endanger the consumers' health.

## Acknowledgments

The authors would like to thank the Student Research Committee of Mashhad University of Medical Sciences. Acknowledgments are due to the supports.

## Funding

This research was funded by the Student Research Committee (Grant: 961342) at the Mashhad University of Medical Sciences in Iran.

## Conflict of interest

The authors confirm that there is no conflict of interest regarding the publication of this article.

This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use.

## References

1. Nafez AH, Darsanj A, Yarmohammadi A, et al. Evaluation of peroxide amount in the consumed oil used in the fast food shops of

- Kermanshah city, Iran, in the year 2016. Health System Research Journal. 2018;13(4):399-404.
2. Fazelpour S, Baghianimoghadam M, Nagharzadeh A, et al. Assessment of fast food consumption among people of Yazd city. Toloo-e-Behdasht. 2011;10(2):25-34.
  3. Ghobadi S, Akhlaghi M, Shams S, et al. Acid and peroxide values and total polar compounds of frying oils in fast food restaurants of Shiraz, Southern Iran. International Journal of Nutrition Sciences. 2018;3(1):25-30.
  4. Grier SA, Mensinger J, Huang SH, et al. Fast-food marketing and children's fast-food consumption: exploring parents' influences in an ethnically diverse sample. Journal of Public Policy and Marketing. 2007;26(2):221-35.
  5. Moore LV, Diez Roux AV, Nettleton JA, et al. Fast-food consumption, diet quality, and neighborhood exposure to fast food: the multi-ethnic study of atherosclerosis. Am J Epidemiol. 2009;170(1):29-36.
  6. Alavi SM, Ebrahimi A, Pourmordini E, et al. Identification and classification of factors affecting the choice of fast food restaurants using factor analysis method. African journal of business management. 2018;9(4):827-54.
  7. Zangiabadi A, Ghanbari R, Alideh R, et al. The survey of environmental health status of restaurants and hotels with dining rooms in the tourist area of central part of Isfahan city using GIS in 2008-2009. Health System Research Journal. 2010;6(3):567-87.
  8. Amoah M, Adonu RE, Paintsil E. The level of awareness of fast food operators on food safety and hygiene practices. Open Access Library Journal. 2018;5(04):1.
  9. Nguyen A, Tran B, Le H, et al. Customers' knowledge, attitude, and practices towards food hygiene and safety standards of personnel in food facilities in Hanoi, Vietnam. Int J Environ Res Public Health. 2018;15(10):2101.
  10. Peiravi R, Vahedian-Shahroodi M, Alidadi H, et al. A survey on the knowledge of environmental health officers in regard to the executive process of the legal item1. Journal of Research in Environmental Health. 2015;1(2): 112-8.
  11. Seif N, Nazem F, Heydari A, et al. Environmental health in hotels of Iranian pilgrims in Najaf in February & January in 2010. Journal of Rescue and Relief. 2012;3(3,4):6-8.
  12. Arbabi M, Deris F. Determination of hydrogen peroxide index in the consumption edible oils in fast food shops. Journal of Shahrekord Uuniversity of Medical Sciences. 2011;13(3):90-9.
  13. Li X, Wu G, Yang F, et al. Influence of fried food and oil type on the distribution of polar compounds in discarded oil during restaurant deep frying. Food Chem. 2019;272:12-7.
  14. Jahed Khaniki G, Safaei P, Barik Gugjlu R, et al. Determination of peroxide value of edible oils used in sandwich and falafel shops in Tehran. Iranian Journal of Health and Environment. 2018;10(4):501-10.
  15. Nayak PK, Dash U, Rayaguru K, et al. Physiochemical changes during repeated frying of cooked oil: A review. J Food Biochem. 2016;40(3):371-90.
  16. Zhang Q, Saleh AS, Chen J, et al. Chemical alterations taken place during deep-fat frying based on certain reaction products: a review. Chem Phys Lipids. 2012; 165(6):662-81.
  17. Debnath S, Rastogi NK, Krishna AG, et al. Effect of frying cycles on physical, chemical and heat transfer quality of rice bran oil during deep-fat frying of poori: An Indian traditional fried food. Food and Bioproducts Processing. 2012;90(2):249-56.
  18. Li L, Adamkiewicz G, Zhang Y, et al. Effect of traffic exposure on sick building syndrome symptoms among parents/grandparents of preschool children in Beijing, PLoS One. 2015;10(6): e0128767.
  19. Andrikopoulos NK, Boskou G, Dedoussis GV, et al. Quality assessment of frying oils and fats from 63 restaurants in Athens, Greece. Food Service Technology. 2003;3(2):49-59.
  20. Cascant MM, Garrigues S, de la Guardia M. Comparison of near and mid infrared spectroscopy as green analytical tools for the

- determination of total polar materials in fried oils. *Microchem J.* 2017;135:55-9.
21. Mlcek J, Druzvikova H, Va Lasek P, et al. Assessment of total polar materials in frying fats from czech restaurants. *Ital J Food Sci.* 2015;27(2):32-7.
22. Dobarganes C, Márquez-Ruiz G, Velasco J. Interactions between fat and food during deep-frying. *Eur J Lipid Sci Technol.* 2000;102(8-9):521-8.
23. Mahboubifar M, Yousefinejad S, Alizadeh M, et al. Prediction of the acid value, peroxide value and the percentage of some fatty acids in edible oils during long heating time by chemometrics analysis of FTIR-ATR spectra. *Journal of the Iranian Chemical Society.* 2016;13(12):2291-9.
24. Dong X, Li Q, Sun D, et al. Direct FTIR analysis of free fatty acids in edible oils using disposable polyethylene films. *Food Analytical Methods Journal.* 2015;8(4): 857-63.
25. El-Abassy RM, Donfack P, Materny A. Rapid determination of free fatty acid in extra virgin olive oil by Raman spectroscopy and multivariate analysis. *J Am Oil Chem Soc.* 2009;86(6):507-11.
26. Nejad Shah Badaghi A, Moeini M, Balarak D, et al. Study of the health status of the restaurant and dining halls in Zahedan in 1395. 12th Annual Congress of Medical Students of the Eastern Medical Sciences universities. Gonabad, Iran. 2017.
27. Zazoli MA, Yousefi M, Ghorzin Motaei F. Study on the environment health status of restaurants and pubs in Qaemshahr in 2012. 3rd National Food Security Conference . Savadkooh, Iran.2013.
28. Rezaee S, Fararouie M, Salehi P, et al. The study of the health status of the fast food environment of Yasuj city and the tendency towards fast food among the general population in 2010. 16th National Conference on Environmental Health. Tabriz, Iran. 2013.
29. Amarloei A, Nikseresht K, Gholami parizad E, et al. Evaluation of peroxide value of oils consumed in food shops (sandwich and falafel) in Ilam City. *Journal of Ilam University of Medical Sciences.* 2019;21(6):182-88.
30. Amiri MS, Joharchi MR. Ethnobotanical investigation of traditional medicinal plants commercialized in the markets of Mashhad, Iran. *Avicenna J Phytomed.* 2013;3(3):254.
31. Miri M, Derakhshan Z, Allahabadi A, et al. Mortality and morbidity due to exposure to outdoor air pollution in Mashhad metropolis, Iran. *Environmental research.* 2016;151:451-7.
32. Sadeghi A, Bonyadi Z. Study on health indicators of pilgrims accommodations places in Samen zone at Holy Mashhad in the summer of 1390. *Journal of Sabzevar University of Medical Sciences.* 2015;22(3):317-23.
33. Ochoa C, Porcar JM. Modeling the effect of quota sampling on online fieldwork efficiency: An analysis of the connection between uncertainty and sample usage. *International Journal of Market Research.* 2018;60(5):484-501.
34. Verma J. Sampling Techniques. Statistics and Research Methods in Psychology with Excel. Springer publication; 2019.
35. Sajjadi SA, Moteallemi A, Bargard ZR, et al. Investigation of cooking oil quality at fast food restaurants in Mashhad City. *Int J Environ Health Eng. Engineering.* 2019;8(1):6.
36. Amiri MS, MR J. Ethnobotanical investigation of traditional medicinal plants commercialized in the markets of Mashhad, Iran. *Avicenna J Phytomed.* 2013;3(3):254-71.
37. Felfelani F, Kerachian R. Municipal water demand forecasting under peculiar fluctuations in population: a case study of Mashhad, a tourist city. *Hydrol Sci J.* 2016;61(8): 1524-34.
38. Najmeddin A, Moore F, Keshavarzi B, et al. Pollution, source apportionment and health risk of potentially toxic elements (PTEs) and polycyclic aromatic hydrocarbons (PAHs) in urban street dust of Mashhad, the second largest city of Iran. *J Geochem Explor.* 2018;190:154-69.
39. Namazkar S, Stockmarr A, Frenck G, et al. Concurrent elevation of CO<sub>2</sub>, O<sub>3</sub> and temperature severely affects oil quality and



- quantity in rapeseed. *J Exp Bot.* 2016;67(14): 4117-25.
40. Zangi Abadi A, Ghanbari R, Aali Dahchenari R, et al. Evaluating the environmental health conditions of restaurants and hotels dining areas in a central tourist area in Isfahan by using GIS in 2008 and 2009. *Journal of Health Research System.* 2010;6(3):567-87.
41. Tavakoli HR, Masoumbeigi H, Ardestani M, et al. Study of environmental health status of food storages and fridges in one of Tehran province military forces in 2012. *Journal of Military Medicine.* 2014;15(4):259-66.
42. Vahidi MH. Report on experience and function of environmental health assessment in food supply and distribution systems in zard village in 2009-2012. 2nd National and 1st International Conference of Best Practices of Primary Health Care. Bojnourd, Iran. 2012.
43. Chen WA, Chiu CP, Cheng WC, et al. Total polar compounds and acid values of repeatedly used frying oils measured by standard and rapid methods. *J Food Drug Anal.* 2013;21(1):58-65.
44. Hassanien M, Sharoba A. Rheological characteristics of vegetable oils as affected by deep frying of French fries. *Journal of food measurement and characterization.* 2014;8(3): 171-9.
45. Serjouie A, Tan CP, Mirhosseini H, et al. Effect of vegetable-based oil blends on physicochemical properties of oils during deep-fat frying. *Am J Food Technol.* 2010;5(5):310-23.
46. Bansal G, Zhou W, Tan T-W, et al. Analysis of trans fatty acids in deep frying oils by three different approaches. *Food Chem.* 2009; 116(2): 535-41.
47. Innawong B, Mallikarjunan P, Marcy JE. The determination of frying oil quality using a chemosensory system. *Lebenson Wiss Technol.* 2004;37(1):35-41.
48. Chao PM, Lin YS. Teratogenic effects of polar compounds in oxidized frying oil. *Med Res Arch.* 2016;4(8):58-63.
49. Ganesan K, Sukalingam K, Xu B. Impact of consumption of repeatedly heated cooking oils on the incidence of various cancers-A critical review. *Crit Rev Food Sci Nutr.* 2019;59(3):488-505.
50. Li X, Yu X, Sun D, et al. Effects of polar compounds generated from the deep-frying process of palm oil on lipid metabolism and glucose tolerance in Kunming mice. *J Agric Food Chem.* 2016;65(1):208-15.
51. Hsu HT, Chen MJ, Tseng TP, et al. Kinetics for the distribution of acrylamide in French fries, fried oil and vapour during frying of potatoes. *Food Chem.* 2016;211:669-78.
52. Azman A, Shahrul SM, Chan S, et al. Level of knowledge, attitude and practice of night market food outlet operators in Kuala Lumpur regarding the usage of repeatedly heated cooking oil. *Med J Malaysia.* 2012;67(1):91-101.
53. Totani N, Tateishi S, Chiue H, et al. Color and chemical properties of oil used for deep frying on a large scale. *J Oleo Sci.* 2012; 61(3):121-6.
54. Rahimzadeh Barzoki H, Beirami S, Mansourian M, et al. Determination of peroxide value of edible oils used in confectionary, restaurants and sandwich shops in Gorgan in 2011. *Toloo-e-Behdasht.* 2014;13(1):40-7.
55. Ramadan MF, Amer MMA, Sulieman AERM. Correlation between physicochemical analysis and radical-scavenging activity of vegetable oil blends as affected by frying of French fries. *Eur J Lipid Sci Technol.* 2006;108(8):670-8.